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(54) **BONDED ELASTOMERIC CONNECTOR**

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H01R 4/58 (2006.01)

(52) **U.S. Cl.** **439/91**; 439/66

(58) **Field of Classification Search** 439/91, 439/66, 591, 74, 86, 87
See application file for complete search history.

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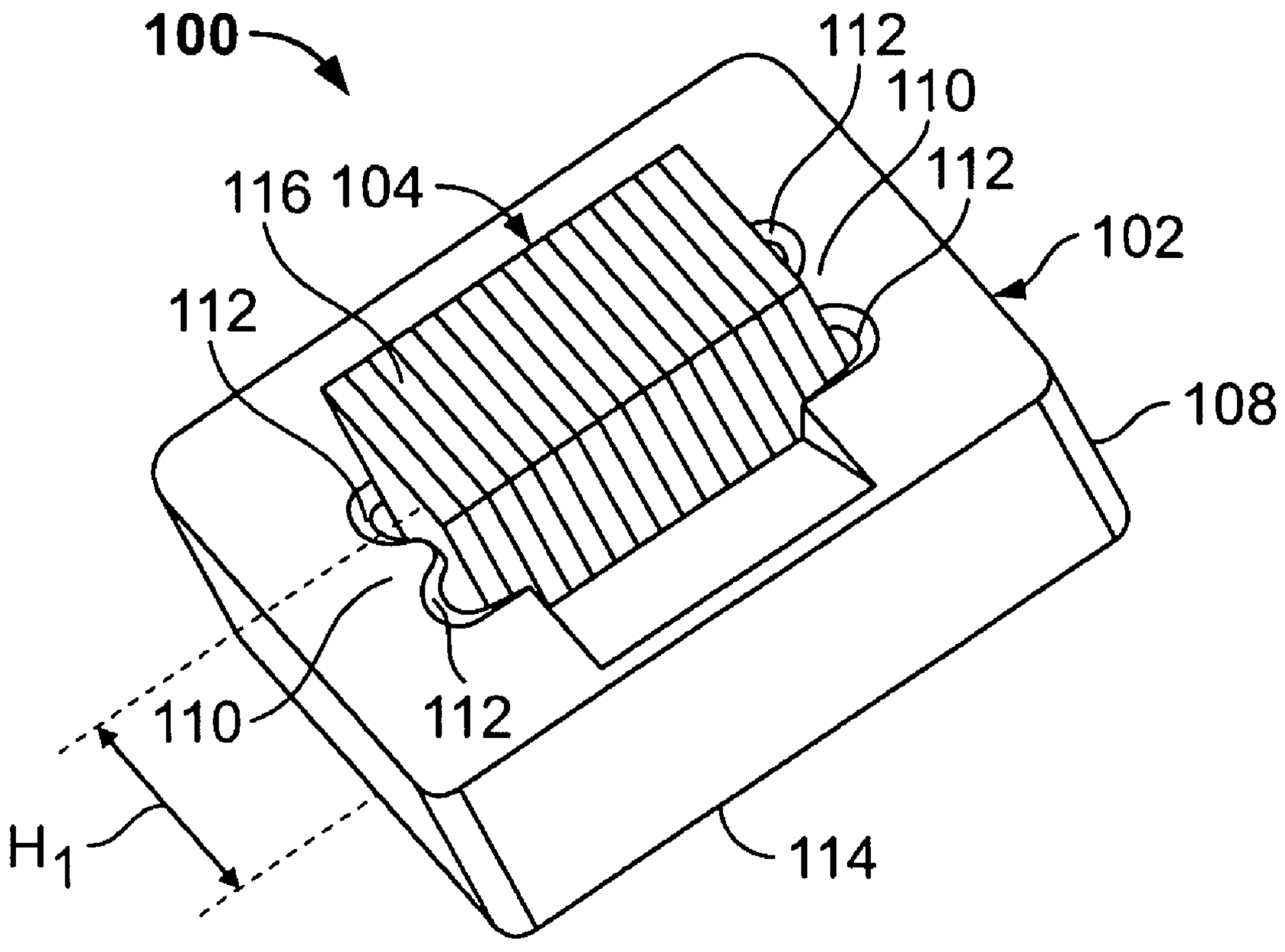
(57) **ABSTRACT**

An electrical connector includes a holder configured to be mechanically and electrically connected to a circuit board. The holder has a surface that is at least partially conductive. A conductive elastomeric member is mounted in the holder and electrically connected to the at least partially conductive surface of the holder. The at least partially conductive surface is configured to convey electrical current between the elastomeric member and the circuit board.

20 Claims, 3 Drawing Sheets



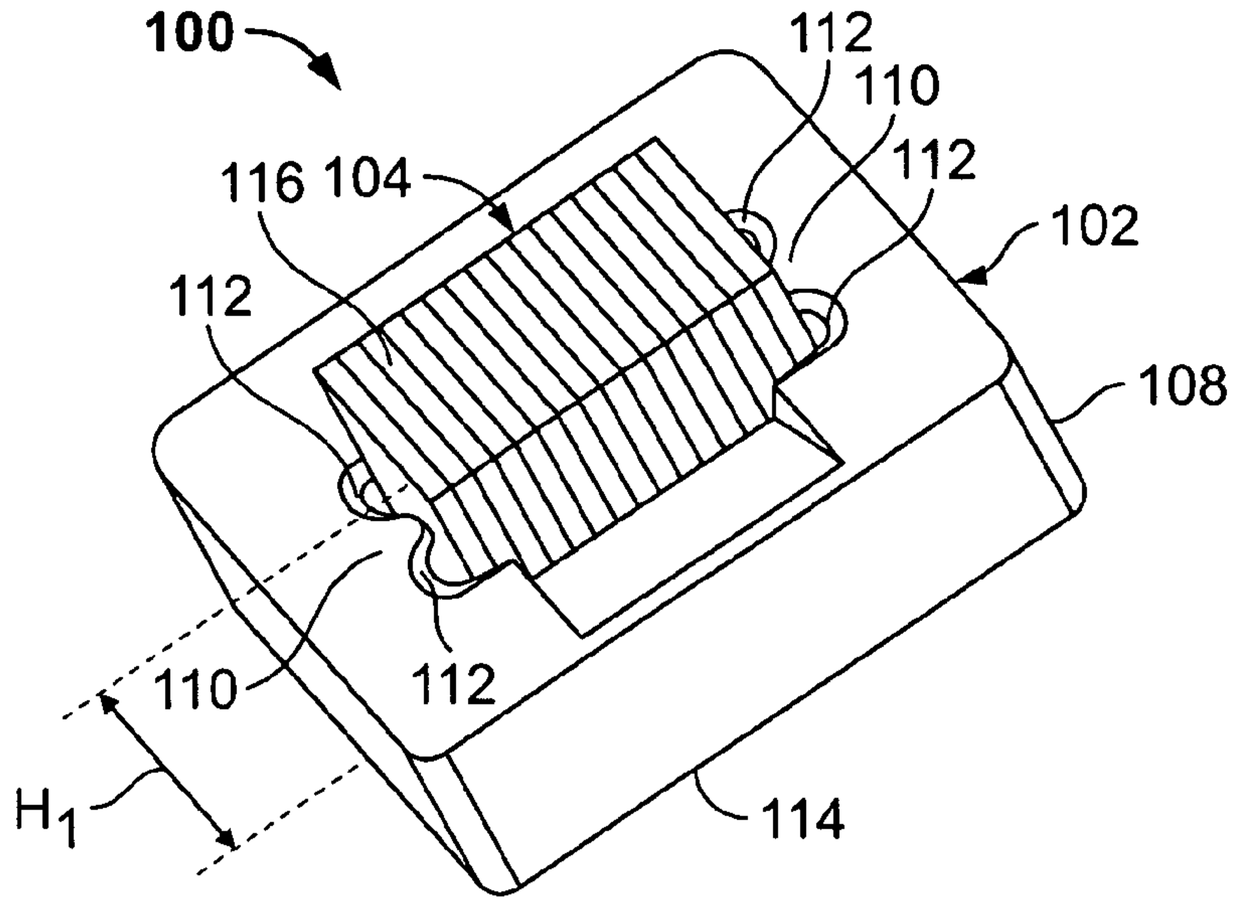
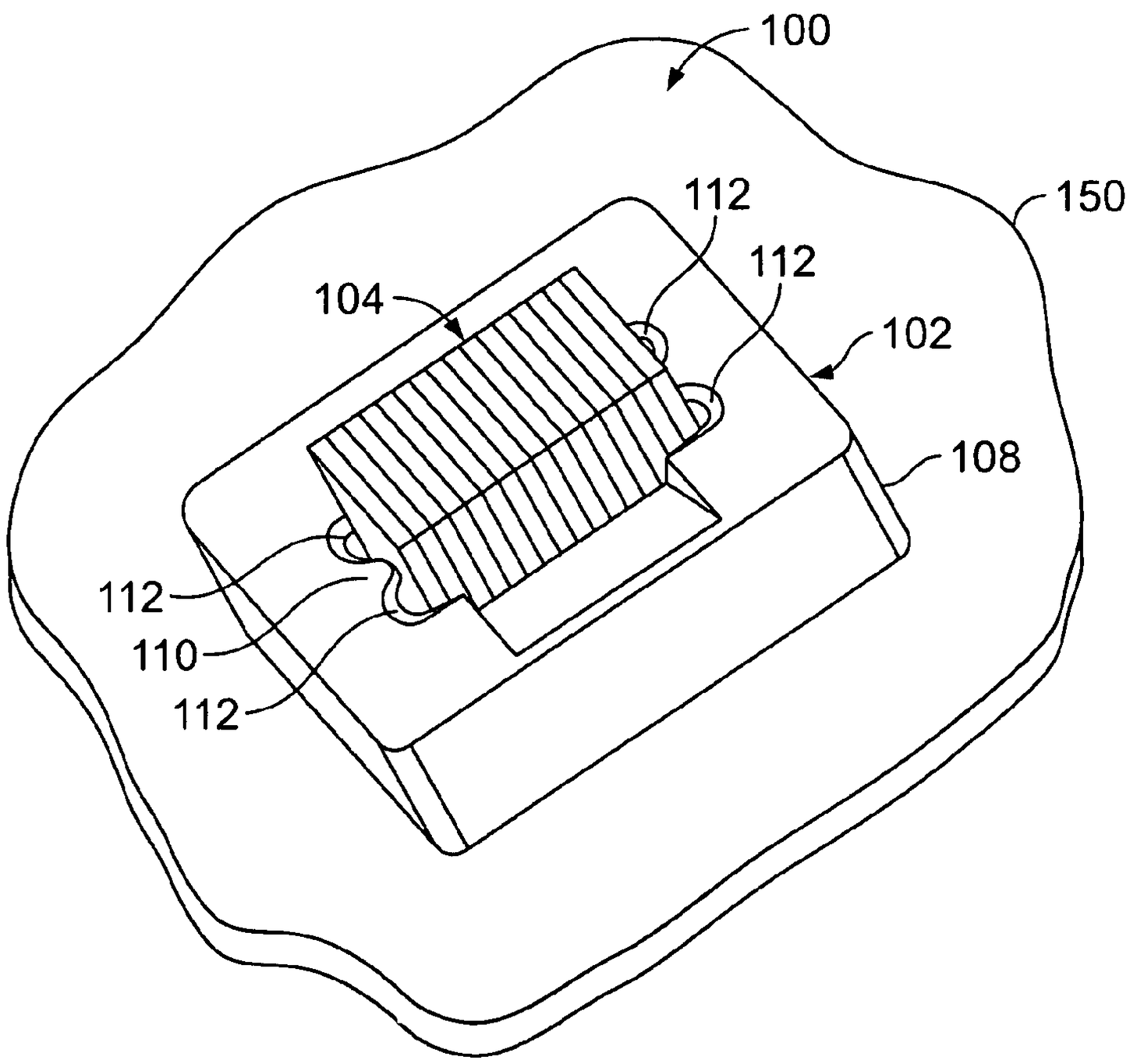

100
112
110
112
116
104
102
112
108
110
112
H_1
114

FIG. 1


100
150
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104
102
108
112
110
112

FIG. 3

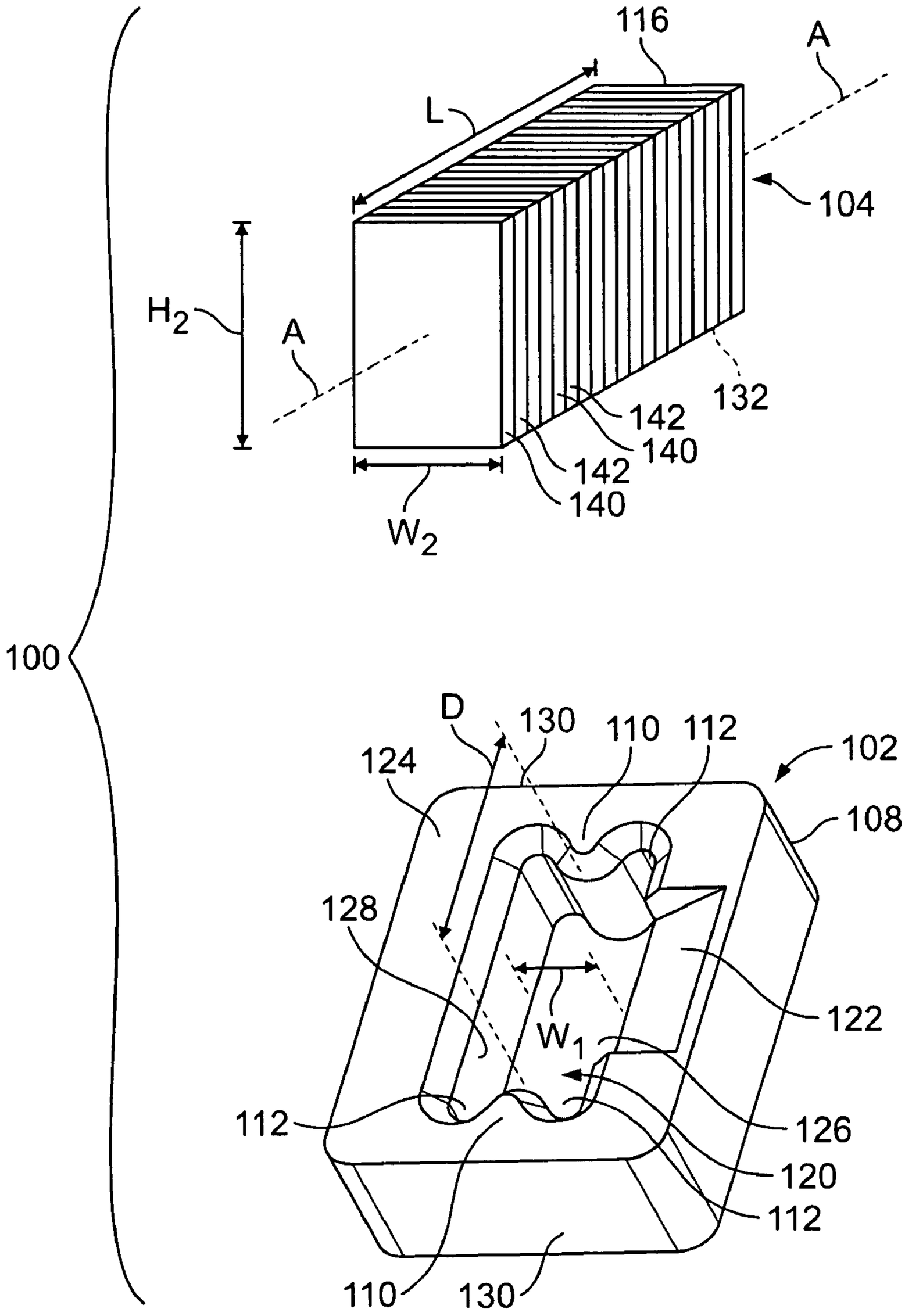
116
A
L
104
H_2
A
132
142
140
142
140
W_2
100
D
130
110
112
102
124
108
128
122
W_1
126
120
112
112
110
130

FIG. 2

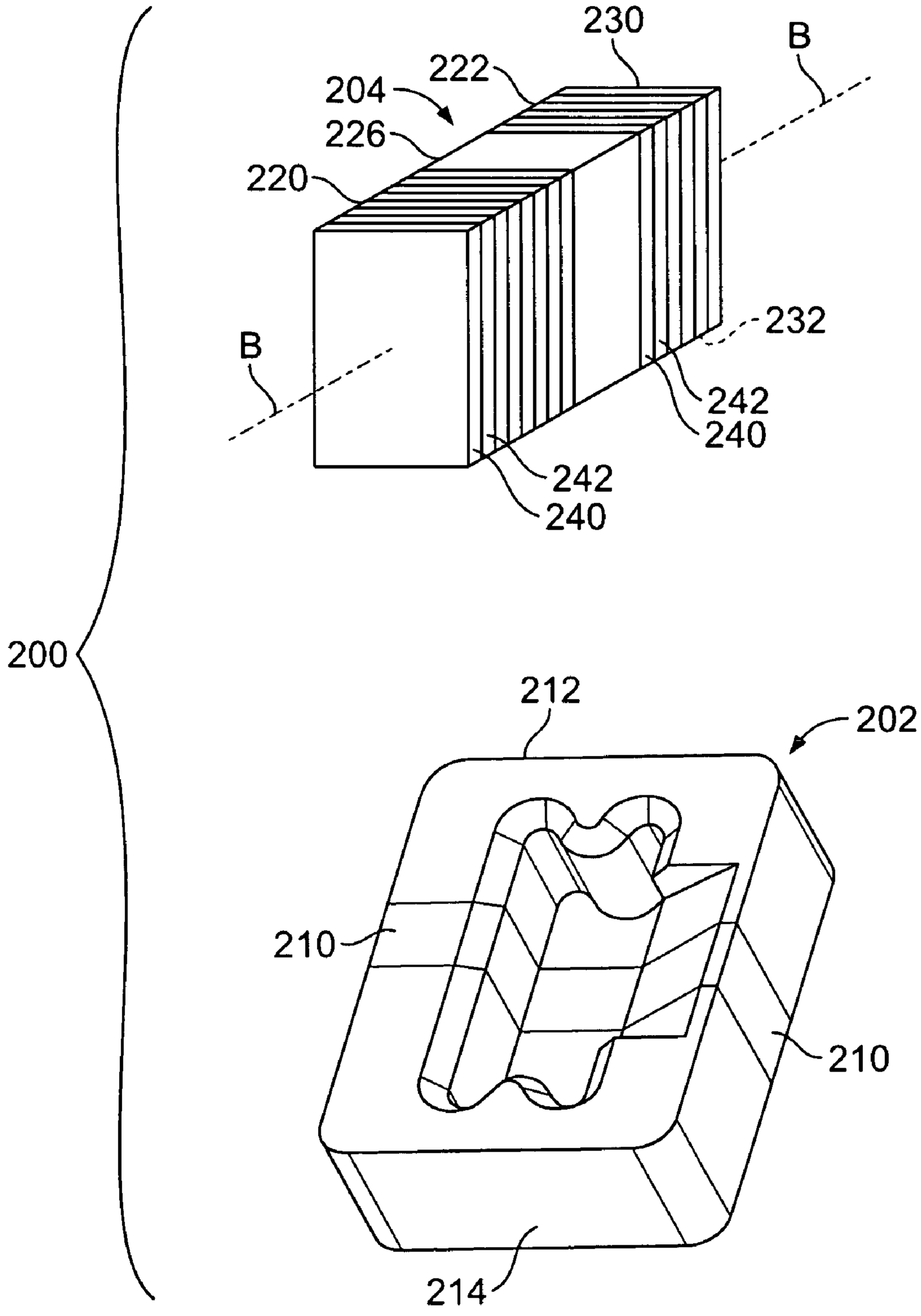
200
230
B
222
204
226
220
232
B
242
240
242
240
212
202
210
210
214

FIG. 4

BONDED ELASTOMERIC CONNECTOR

BACKGROUND OF THE INVENTION

The invention relates generally to electrical connectors and, more particularly, to a bonded elastomeric connector for making connections between substrates.

Many electronic applications utilize single contact connections to make a connection between substrates. For example, in a mobile phone application, a single contact connector may be used for making a grounding connection between two circuit boards. Typically, pogo pin type connectors or stamped and formed connectors are used for making such single contact connections. In addition, multiple pogo pin or stamped and formed connectors are often used to make connections to components such as speakers, ringers, or vibration motors and the like.

The aforementioned connector solutions have certain shortcomings, such as, for instance, they require custom tooling to manufacture and have long lead times. In particular, as electronic packages become progressively smaller, the size of the connectors must also become smaller and in many instances, the traditional connector designs become inadequate. In particular, there is a limit to how small a pogo pin connector can be made. Not only are there size limits for the pogo pin components, but at its limits, the deflection range becomes insufficient. In addition, the connector becomes even more costly as the size is reduced.

The aforementioned concerns have led to the increasing use of elastomeric connectors in electronic devices. The elastomer in the elastomeric connector maintains some of its flexibility even when reduced in size. One type of elastomeric connector includes alternating layers of a conductive and non-conductive elastomeric material such as silicon rubber, with the conductive layers formed with layers of silicon material impregnated with electrically conductive material such as carbon, gold, or silver, and the like. The non-conductive or dielectric elastomer layers are sandwiched between the conductive layers and are of sufficient thickness to insulate the conductive layers from one another.

It remains a challenge to provide a low profile low cost connector that is easily modified for multiple applications, that requires little tooling, and may be produced with short lead times.

BRIEF DESCRIPTION OF THE INVENTION

In one aspect, an electrical connector is provided. The connector includes a holder configured to be mechanically and electrically connected to a circuit board. The holder has a surface that is at least partially conductive. A conductive elastomeric member is mounted in the holder and electrically connected to the at least partially conductive surface of the holder. The at least partially conductive surface is configured to convey electrical current between the elastomeric member and the circuit board.

Optionally, the holder includes a pocket having a closed bottom and a side wall that has positioning ribs to locate the elastomeric member in the pocket. The holder is fabricated from a nonconductive platable material that is at least partially plated with a conductive material to provide a surface that is at least partially conductive. The holder may be stamped and formed from a metal material. The holder includes a receiving area open to an upper surface of the holder to receive an adhesive. The elastomeric member is bonded to the holder. The elastomeric member includes a plurality of conductive layers and nonconductive layers in an alternating arrangement. The bottom of the pocket and the side wall around the pocket of the holder are conductive. The conductive layers electrically engage at least one of the bottom and the side wall.

In another aspect, an electrical connector is provided that includes a holder configured to be mechanically connected to a circuit board. The holder includes a pocket having a relief area formed therein. A conductive elastomeric member is mounted in the pocket. The relief area facilitates deflection of the elastomeric member within the pocket.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a bonded elastomeric connector formed in accordance with an exemplary embodiment of the present invention.

FIG. **2** is an exploded view of the elastomeric connector shown in FIG. **1**.

FIG. **3** is a perspective view of the bonded elastomeric connector mounted on a circuit board.

FIG. **4** is an exploded view of an elastomeric connector formed in accordance with an alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** is a perspective view of a bonded elastomeric connector **100** formed in accordance with an exemplary embodiment of the present invention. The connector **100** includes a holder **102** and an elastomeric member **104**. The holder **102** includes a body **108** that is formed with positioning ribs **110** and relief areas **112**. The elastomeric member **104** is mounted in the holder **102** between the positioning ribs **110**. In the illustrated assembled connector **100**, the elastomeric member **104** is bonded to the holder **102** forming an integrated assembly. The connector **100** has an overall height H_1 from a first mating surface at a base **114** of the holder **102** to an upper contact surface **116** of the elastomeric member **104**.

FIG. **2** is an exploded view of the elastomeric connector **100**. The body **108** includes a pocket **120** that receives the elastomeric member **104**. The positioning ribs **110** are formed at opposite ends of the pocket **120**, a distance D apart. The pocket **120** has a width W_1. A receiving area **122** is provided in the body **108** for the admission of an adhesive into the holder **102**. In one embodiment, the receiving area **122** is in the form of a ramped section or bevel formed in, and open to, an upper surface **124** of the holder body **108**. The pocket **120** includes a closed bottom **126** and a side wall **128** that completely surrounds the pocket **120** and defines the positioning ribs **110** and the relief areas **112**. In one embodiment, the positioning ribs **110** and the relief areas **112** are located proximate end sections **130** of the holder **102**. The relief areas **112** are recessed from the positioning ribs **110** toward the end sections **130** such that the positioning ribs **110** and relief areas **112** form M shapes in the side wall **128**. In alternative embodiments, other geometries for the positioning ribs **110** and relief areas **112** are also contemplated.

The holder **102** includes a surface that is at least partially electrically conductive. In an exemplary embodiment, the holder **102** is molded from a platable plastic material and plated with a conductive material to provide surfaces that are at least partially conductive. In some embodiments, the holder **102** may be plated over its entire surface. In an alternative embodiment, the holder **102** may be stamped and formed from metal.

The elastomeric member **104** is a conductive member that has a height H_2 between a first or upper contact surface **116** and a second or lower contact surface **132** that is opposite the first contact surface **116**. The elastomeric member **104** has a length L that is approximately the same as the distance D between the positioning ribs **110** in the holder **102** and a width W_2 that is approximately the same as the width W_1 of the pocket **120** in the holder **102**. The elastomeric member **104** is substantially rectangular in shape, although it is to be appreciated that other shapes may be formed in other embodiments. The elastomeric member **104** includes a plurality of conductive layers **140** together with a plurality of nonconductive layers **142**. The conductive layers **140** are separated from one another by nonconductive layers **142**. Each of the conductive and nonconductive layers **140** and **142**, respectively, is substantially perpendicular to a longitudinal axis A through the elastomeric member **104**. In an alternative embodiment, however, the conductive layers **140** and nonconductive layers **142** may extend at other orientations, including parallel, with respect to the longitudinal axis A.

The nonconductive layers **142** separate the conductive layers **140**, so that discrete current paths are formed through the individual conductive layers **140** between the upper contact surface **116** and the lower contact surface **132** enabling current flow therebetween while the nonconductive layers **142** prevent current leakage between the conductive layers **140**. In an exemplary embodiment, the nonconductive layers **142** are fabricated from a known dielectric or insulating material, such as silicone rubber, and the conductive layers **140** are fabricated from a known particle filled or impregnated silicone elastomer. The elastomeric member **104** may include any number of conductive layers **140** and nonconductive layers **142** as called for in a given application. Further, each conductive layer **140** may include sublayers of conductive material, and each nonconductive layer **142** may include sublayers of nonconductive material. In alternative embodiments, the conductive layers and nonconductive layers **140** and **142** may be formed into the same or different thicknesses from one another. Further, when the connector **100** is used as one contact, the elastomeric member **104** may include a single block of conductive material.

The elastomeric member **104** is loaded into and bonded to the pocket **120** of the holder **102** after the holder **102** is plated so that the elastomeric member **104** and the holder **102** form a conductive unit. The bottom **126** and the side wall **128** of the pocket **120** are at least partially conductive. When the elastomeric member **104** is loaded into the pocket **120**, the conductive layers **140** of the elastomeric member **104** electrically engage at least one of the bottom **126** and the side wall **128** of the pocket **120**. The elastomeric member **104** is loaded into the pocket **120** in the holder body **108** between the positioning ribs **110** which locate the elastomeric member **104** in the pocket **120**. The relief areas **112** in the holder body **108** enable low force deflection of the elastomeric member **104**. The elastomeric member **104**, though deformable, is only minimally compressible. The relief areas **112** provide space into which the elastomeric member **104** can flow when deflection forces are applied to the elastomeric member **104**.

FIG. **3** is a perspective view of the bonded elastomeric connector **100** mounted on a circuit board **150**. In an exemplary embodiment, the elastomeric member **104** is mounted in and bonded to the holder **102** which is reflow soldered to the circuit board **150** to mechanically and electrically connect the holder **102** to the circuit board **150**. The elastomeric member **104** is electrically connected to the

holder **102**. When mounted on the circuit board **150**, the connector **100** provides a current flow path from a mating circuit board (not shown) through the elastomeric member **104**, to the holder **102**, and to the circuit board **150**. The relief areas **112** in the holder **102** enable the connector **100** to provide a low force connection between the circuit board **150** and the mating board (not shown). The height H_1 of the connector **100** is determined by and can be varied by adjusting the height H_2 of the elastomeric member **104**. As illustrated in FIG. **3**, the connector **100** is configured to make one contact or connection. In an exemplary embodiment, the connector **100** has a height H_1 of about 2.25 millimeters and may be used, as an example, to provide a grounding or shorting connection between circuit boards in a cellular phone. In alternative embodiments, the connector may be configured to provide multiple contacts as described below.

FIG. **4** is an exploded view of an elastomeric connector **200** formed in accordance with an alternative embodiment of the present invention. The connector **200** includes a holder **202** and an elastomeric member **204**. The holder **202** and the elastomeric member **204** are similar to the previously described holder **102** and elastomeric member **104** and the detailed description of the holder **202** and elastomeric member **204** will be limited to the differences from the previously described embodiment.

The connector **200** is configured to provide two contacts or connections between two circuit boards (not shown). The holder **202** is molded with a ribbon of non-platable plastic **210** between end sections **212** and **214** which are molded from platable plastic such that when the holder **202** is plated, two conductive portions **212** and **214** are formed separated by a nonconductive section at the ribbon of non-platable plastic **210**.

The elastomeric member **204** includes a first conductive element **220** and a second conductive element **222** that are separated by an isolating section **226**. The conductive elements **220** and **222** and the isolating section **226** extend between a common first or upper contact surface **230** and a common second or lower contact surface **232**. Each conductive element **220** and **222** includes a plurality of conductive layers **240** together with a plurality of nonconductive layers **242**. The conductive layers **240** are separated from one another by nonconductive layers **242**. Each of the conductive and nonconductive layers **240** and **242**, respectively, is substantially perpendicular to a longitudinal axis B through the elastomeric member **204**. The isolating section **226** is similarly oriented. In an alternative embodiment, the conductive layers and nonconductive layers **240** and **242** may extend at other orientations, including parallel, with respect to the longitudinal axis B on either side of the isolating section **226**.

The conductive elements **220** and **222** provide separate current paths through the elastomeric member **204** between the first contact surface **230** and the second contact surface **232**. When mounted and bonded in the holder **202**, the conductive elements **220** and **222** are positioned and aligned with the conductive end sections **212** and **214** of the holder **202**. The isolating section **226** of the elastomeric member **204** is positioned and aligned with the non-platable ribbon **210** in the holder **202** such that the bonded connector **200**, as illustrated in FIG. **4** provides two contacts or connections. It is to be understood, however, that in other embodiments, other numbers of contacts may be provided to meet application requirements.

In a two contact configuration, such as the connector **200**, the two contacts of the connector may be used, as an example, to provide a positive and a negative contact

combination to support speaker, ringer, or vibration motor connections in cellular phones.

The embodiments thus described provide a low profile, low cost connector that is an easily customizable alternative to a pogo pin connector for making electrical connections between two substrates. The connector provides a low force connector solution that is reflow solderable to a circuit board. The combination of the elastomeric member and plated plastic holder provides a low profile, inexpensive, connector that may be customized with no tooling and may be produced with a short lead time.

While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.

The invention claimed is:

1. An electrical connector comprising:

a holder having a base configured to be mounted on and electrically connected to a circuit board, said holder having a pocket and having opposed end sections and opposed side walls formed integral with one another and completely surrounding said pocket, one of said side walls and end sections having a conductive surface; and

a conductive elastomeric member mounted in said pocket and electrically connected to said conductive surface of said pocket, said end sections and side walls completely surrounding said elastomeric member, said conductive surface being configured to convey electrical current between said elastomeric member and said base of said holder to the circuit board.

2. The connector of claim **1**, wherein said pocket includes a relief area formed therein to facilitate deflection of said elastomeric member within said holder.

3. The connector of claim **1**, wherein said pocket has a closed bottom that includes said conductive surface to electrically couple said elastomeric member to said pocket, said closed bottom formed integral with said end sections and said side walls, said closed bottom forming a part of the base, said closed bottom being configured to be mounted on the circuit board.

4. The connector of claim **1**, wherein said holder is fabricated from a nonconductive plateable material that is at least partially plated with a conductive material to provide said conductive surface.

5. The connector of claim **1**, wherein said holder includes a receiving area open to an upper surface of said holder to receive an adhesive.

6. The connector of claim **1**, wherein at least one of said side walls has said conductive surface to electrically couple said pocket to said elastomeric member.

7. The connector of claim **1**, wherein said elastomeric member comprises a plurality of conductive layers and nonconductive layers in an alternating arrangement, and wherein said conductive surface is provided on one of said side walls, said conductive layers electrically engaging said conductive surface on one of said side walls.

8. The connector of claim **1**, wherein said holder includes first and second conductive said end sections separated by a nonconductive ribbon and said elastomeric member includes first and second conductive elements separated by an isolating section, said isolating section being aligned with said nonconductive ribbon when said elastomeric member is mounted in said holder.

9. An electrical connector comprising:

a holder having a base that is configured to be mounted on and electrically connected to a circuit board, said holder including a side wall and a closed bottom formed integral with one another and shaped to define a pocket, one of said side wall and closed bottom having a conductive surface, said side wall having a relief area formed therein, said closed bottom being configured to be mounted on the circuit board; and

a conductive elastomeric member mounted in said pocket and on said closed bottom, said relief area facilitating deflection of said elastomeric member within said pocket, said conductive surface being configured to convey electrical current between said elastomeric member and the circuit board.

10. The connector of claim **9**, wherein said holder includes opposed end sections and opposed side walls that are formed integral with one another and entirely surrounds said pocket, said end sections and side walls being formed integral with said closed bottom, said conductive surface being provided on at least one of said closed bottom and said side wall.

11. The connector of claim **9**, wherein said holder is fabricated from a nonconductive plateable material that is at least partially plated with a conductive material to provide said conductive surface on said pocket.

12. The connector of claim **9**, wherein said holder includes a receiving area open to an upper surface of said holder to receive an adhesive, said relief area extending from said upper surface to said closed bottom.

13. The connector of claim **9**, wherein said elastomeric member is bonded to said holder.

14. The connector of claim **9**, wherein said elastomeric member comprises a plurality of conductive layers and nonconductive layers in an alternating arrangement, and wherein said closed bottom includes said conductive surface thereon, said conductive layers electrically engaging said conductive surface on said closed bottom.

15. The connector of claim **9**, wherein said holder includes first and second conductive end sections separated by a nonconductive ribbon and said elastomeric member includes first and second conductive elements separated by an isolating section, said isolating section being aligned with said nonconductive ribbon when said elastomeric member is mounted in said holder.

16. The connector of claim **9**, wherein said base of said holder is configured to be reflow solderable to a circuit board.

17. The connector of claim **1**, wherein holder further comprises a closed bottom in said pocket, said closed bottom being located between said elastomeric member and the circuit board on which the holder is to be mounted.

18. The connector of claim **9**, wherein said closed bottom is located between said elastomeric member and the circuit board to which the holder is to be mounted.

19. The connector of claim **3**, wherein said elastomeric member includes upper and lower contact surfaces, said lower contact surface engaging said closed bottom of said holder, said upper contact surface being configured to electrically engage a second circuit board.

20. The connector of claim **9**, wherein said elastomeric member includes upper and lower contact surfaces, said lower contact surface engaging said closed bottom of said holder, said upper contact surface being configured to electrically engage a second circuit board.

* * * * *